

# PROCESS FOR THE COLOR ENHANCEMENT OF GEMSTONES

## FIELD OF THE INVENTION

The present invention relates to methods for enhancing the color of gemstones and to novel colored gemstones produced by invention methods.

## 5 BACKGROUND OF THE INVENTION

A variety of materials having the physical and aesthetic properties desirable for use as gemstones are widely available. However, many of these materials but do not always have an aesthetically pleasing appearance. A variety of procedures have been employed in the art to improve the physical and/or aesthetic properties of minerals, e.g., electron  
10 beam irradiation, Cobalt-60 irradiation, neutron bombardment, exposure to intense heat, and the like.

More recently, the inventor herein developed a process for enhancing a minerals usable as gemstones by subjecting a combination of a gemstone and at least one form of cobalt metal or cobalt oxide to conditions suitable to enhance the color of said gemstone,  
15 without causing a significant level of surface damage to said gemstone. United States Patent No. 5,888,918 was issued to cover said process. Using said process chrysoberyl, garnet, sapphire and topaz were modified to have colors in the spectrum of from light green to dark blue, depending on the gemstone, the treating agent(s) and treating conditions employed. Quartz was modified to have a light pink to a dark pink color using  
20 the same cobalt metal/oxide process.

Although the methods of the prior art have been able to produce colors in

gemstones ranging from green to blue, none of the state of the art processes have been able to produce gemstones outside the green to blue spectrum except with quartz. And specifically, treatment of the gemstones with cobalt and/or cobalt oxides prevent obtaining gemstones in the color of the present invention. In addition, the treatment  
5 process of the current invention results in gemstone enhancement occurring in a far shorter time period.

Therefore, it would be desirable to be able to readily impart predictably enhanced and/or modified colors to materials useful as gemstones employing readily practicable methods which do not suffer from the drawbacks of prior art methods and which produce  
10 other colors.

### BRIEF DESCRIPTION OF THE INVENTION

In accordance with the present invention, methods have been developed for enhancing the color of minerals useful as gemstones. The methods include the process of subjecting the gemstones to a selected temperature while in the presence of a form of a  
15 selected metal, or metal oxide, such copper/copper oxide, for a selected period of time. Invention methods are relatively inexpensive to carry out, avoid the use of hazardous materials, and require no specialized equipment.

### DETAILED DESCRIPTION OF THE INVENTION

20 In accordance with the present invention, there are provided methods for enhancing the color of gemstones, said methods comprising: subjecting a combination of a gemstone

and at least one powdered (i.e., finely divided) form of copper metal or copper oxide to conditions suitable to enhance the color of said gemstone, without causing a significant level of surface damage to said gemstone. To achieve color enhancement according to the invention, gemstones are placed in a suitable vessel (e.g., a flat ceramic sheet, a crucible, and the like) which can withstand the exposure temperatures contemplated for use, with the gemstones completely surrounded by the treating agent(s) of choice. The vessel is then placed in a furnace capable of reaching and accurately maintaining the selected temperature. Although copper metal or copper oxide are the selected treating agents for the preferred embodiments of the invention, it should be noted that other metals and or metal oxides similarly impart a color that lies in the color spectrum of light yellow to red, e.g., iron, however copper metal or copper oxide appears to cause less surface damage to the gemstone.

A wide variety of minerals can be treated according to the present invention. Examples of suitable minerals contemplated for use herein, thereby rendering them useful as gemstones, include topaz, sapphire, and the like.

A wide variety of metals can be employed in combination with the selected copper metal or copper oxide employed in the invention process. Examples of suitable metals include transition metals, as well as other metals, which can modify the color imparted by the treating agent and/or the mineral being treated.

A wide variety of metals and/or metal oxides can also be employed in combination with the copper metal or copper oxide employed in the invention process, optionally in

further combination with a plurality of the metals set forth hereinabove. Metal oxides are used that can modify the color imparted by the treating agent and/or the mineral being treated, or to dilute the coloring agent to enable control of the saturation of color to the host material, and thereby controlling the amount of surface damage that may occur on the surface of the gemstone. The selection of metal oxide depends on the selected gemstone, and the amount of damage that may occur on the surface of the gemstone. For example, aluminum oxide may work as a diluting agent, but because aluminum oxide reacts with copper, a lesser amount of copper reacts with topaz resulting is a less saturated color. On the other hand magnesium oxide serves as an excellent diluter.

Enhanced colors which can be imparted by the invention process can be varied based on such variables as the particular gemstone being treated, the particular treating agent(s) employed, the conditions to which the gemstones are subjected, and the like. For example, topaz can be modified to have a light yellow to orange color, or a light pink to reddish color, depending on the treating agent(s) and treating conditions employed. Additionally, increasing or reducing the amount of oxygen present during treatment may affect the color itself. For example, after treating the topaz in color to impart a yellow color to the topaz, and then subjecting the enhanced topaz in a reducing atmosphere at about 800° C for about 4 hours, the color will begin to develop a red hue. Sapphire can be treated to have a light yellow to an orange color, and may be treated at a higher temperature than topaz. In general silicate minerals at high temperature will reduce to glass, where sapphire, being an oxide mineral, can withstand a much higher temperature.

A wide range of treating conditions can be employed in the practice of the present invention. Typically conditions suitable to enhance the color of a gemstone, without causing a significant level of surface damage thereto, comprise subjecting the combination of gemstone and at least one powdered (i.e., finely divided) form of copper metal or copper oxide to a temperature in the range of about 800° C. or lower up to about 1000° C. It has been noted with the current process that gemstones may be treated at a temperature lower than 800° C, however, the treatment time will be extended. For example, treatment at about 725° C will result in a treatment time of approximately 72 hours, more or less, depending on the intensity of the color desired. On the other hand treatment at or about 700° C may require a significant increase in treatment time. Typically such contacting is carried out at ambient pressure.

Generally, longer exposure times and/or higher exposure temperatures lead to a greater intensity of color being imparted to the mineral being treated, as well as impacting the degree of color saturation achieved by the process. As readily recognized by those of skill in the art, higher treating temperatures are also possible (i.e., >1250° C.), i.e., sapphire, while also providing higher color saturation. The resulting treated gemstone could be polished to remove the surface damage, thereby providing a color-enhanced gemstone with a satisfactory surface finish.

As readily recognized by those of skill in the art, the particular temperature ranges and exposure times will not only vary as a function of the intensity, but also on the level of color saturation desired. In addition, the ability of a given mineral to withstand such

exposures without suffering significant fracturing must also be considered. Thus, for example, topaz would not typically be subjected to conditions as rigorous as sapphires.

In a particular aspect of the invention, the gemstone to be treated can optionally be contacted with a variety of post-treating agents (e.g., oxygen, reducing agents, and the like) before being subjected to the above-described conditions suitable to enhance the color of a gemstone. By post-treating the gemstones in an oxygen atmosphere, the gemstones may be made more yellow, while post-treating the gemstones in a reducing atmosphere, the gemstones begin to take on a red tint, ranging from orange through pink to red.

While gemstones can be used in the invention treating process without any special pretreatment, it is presently preferred that gemstones subjected to the practice of the invention be cleaned prior to being subjected to said conditions suitable to enhance the color thereof. Suitable cleaning processes are well known to those of skill in the art, and include washing in water, aqueous acid, organic media, and the like.

Gemstones treated according to the present invention can be used directly, or they can be subjected to further treatment and/or washing conditions. It is presently preferred that the treated gemstone be cleaned after being subjected to said conditions suitable to enhance the color of a gemstone. Such cleaning can be accomplished in a variety of ways, e.g., by washing the treated gemstones with aqueous media or with organic solvents (e.g., acetone), by wiping the gemstones with a soft cloth (e.g., a polishing cloth), by polishing the surface of the gemstones with a suitable abrasive, and the like.

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	